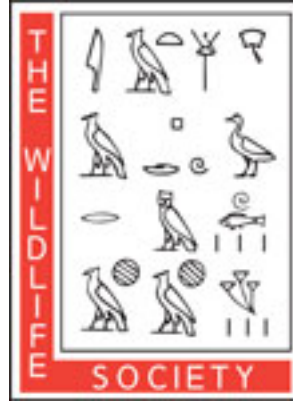


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Author(s): Richard D. Weir and Alton S. Harestad

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SCALE-DEPENDENT HABITAT SELECTIVITY BY FISHERS IN SOUTH-CENTRAL BRITISH COLUMBIA

RICHARD D. WEIR,^{1,2} Department of Biological Sciences, Simon Fraser University, Burnaby, BC V5A 1S6, Canada
ALTON S. HARESTAD, Department of Biological Sciences, Simon Fraser University, Burnaby, BC V5A 1S6, Canada

Abstract: We examined habitat selectivity by fishers (*Martes pennanti*) at 3 spatial scales in south-central British Columbia, Canada, from 1990 to 1993. We monitored radiomarked fishers and compared their use of habitats with the availability of these habitats at stand, patch, and element spatial scales. Fishers exhibited habitat selectivity for a variety of resources at different spatial scales. They selected habitats based on overhead cover, foraging, and snow interception at the stand and patch spatial scales. Habitats used by fishers for resting and denning were selected at all 3 spatial scales. When using stands or patches of habitat in which the density of resources may have been low, fishers appeared to compensate by selecting, at smaller scales, areas of higher-quality habitat. Because fishers select resources across several spatial scales, knowledge of which habitat requirements can be fulfilled at each scale allows for more effective and flexible management of fisher habitats.

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Key words: British Columbia, element, fishers, habitat, habitat selection, *Martes pennanti*, patch, spatial scale, stand.

Interpretation of previous studies on habitat use by fishers has been constrained by at least 2 factors: differences in forest types among areas and differences in scale among studies. Fishers inhabit a broad range of habitats across their geographic distribution, from deciduous forests of New Hampshire, USA (Kelly 1977), to coniferous forests of the Western Cordillera in British Columbia, Canada (Powell 1993). Major differences in vegetative composition, stand structure, and spatial characteristics among these forest types impede extrapolation to other regions. Most researchers have not explicitly defined the spatial scale over which habitat relationships they studied were examined.

Johnson (1980) hypothesised that animals select resources at several different spatial scales, which he labelled “selection orders.” These selection orders occur at the geographic extent of the species (first order), the selection of a home range (second order), the selection of stands within the home range (third order), and the selection of particular sites for feeding or resting (fourth order). Lofroth (1993) identified an additional selection level between the third and fourth order: selection of patches within larger tracts of habitat that are homogeneous with regard to broad habitat characteristics (i.e., stands). Resources required by a species may be found at any or all of these scales.

The latter 3 habitat selection orders are similar to the spatial scales used to describe forest ecosys-

tem dynamics (Pickett and Thompson 1978). These dynamics generally can be classified from coarse- to fine-grained, into stand, patch, and element scales. Within this scale-based system, selection order is hierarchical: stand-scale selection occurs during the selection of stands within the home range, patch-scale selection occurs for patches within stands, and element-scale selection occurs for elements within patches (Fig. 1).

One underlying problem that restricts the utility of most studies of fisher habitat is that the re-

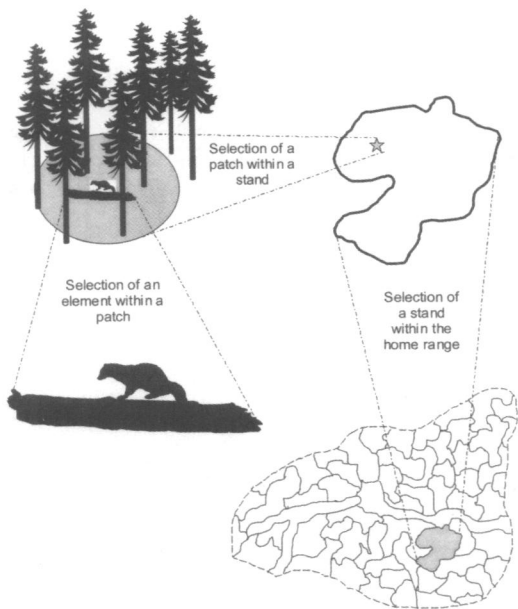


Fig. 1. The hierarchical nature of scale. Habitat occurs at each spatial scale, and animals can express selectivity at each scale.

¹ Present address: Artemis Wildlife Consultants, 4515 Hullcar Road, Armstrong, BC V0E 1B4, Canada.

² E-mail: rweir@artemiswildlife.com

searchers often have not explicitly identified the spatial scales at which habitat relationships were examined. Many researchers have quantified habitat selection at the stand scale (Kelly 1977, Powell 1977, Johnson 1984, Arthur et al. 1989) and only identified habitats that were used at other spatial scales without testing for selectivity. Powell (1994) reported that fishers in Michigan selected patches with porcupine dens in otherwise "unsuitable" stands, but he did not compare use with availability. Several studies have also described elements, such as hollow trees and downed logs, used by fishers for whelping and resting (Powell 1977, Arthur 1987, Paragi 1990, Jones 1991, Powell et al. 1997). Unfortunately, most studies did not compare use of these elements to availability or failed to distinguish the spatial scale of selectivity. Failure to define the spatial scale at which habitat relationships were examined has led to inconsistent or possibly inappropriate management applications when findings from 1 region were applied to fishers in other regions.

Our objective was to examine habitat selection by fishers in the dry-warm subzone of the Sub-Boreal Spruce Biogeoclimatic zone (SBSdw) in south-central British Columbia. We compared habitats used by fishers to those available at 3 spatial scales: stand, patch, and element. Knowledge of the resource requirements of fishers at different spatial scales will improve the effectiveness of habitat management and extend management options beyond prescriptions at the stand spatial scale.

STUDY AREA

Our 1,500-km² study area was centered 65 km northeast of Williams Lake, British Columbia (52°10'N, 122°10'W) and was entirely within the SBSdw. The Sub-Boreal Spruce Biogeoclimatic zone is a heavily forested, coniferous, montane region that dominates the landscape of the central interior of British Columbia and generally occurs from valley bottoms (300 m) to 1,300 m above sea level (Meidinger et al. 1991). The climate of the SBSdw is continental and characterized by severe, snowy winters and relatively warm, moist, and short summers. Mean annual temperatures were 3.4–3.7 °C, annual precipitation was typically 51 cm, and mean annual snowfall was 190 cm (Steen and Coupé 1997). Snow depth under the forest canopy reaches 40–60 cm during late February.

Forests in our study area were dominated by Douglas-fir (*Pseudotsuga menziesii*), lodgepole pine (*Pinus contorta*), and hybrid white spruce (*Picea engelmannii* × *glauca*), with minor decidu-

ous components of trembling aspen (*Populus tremuloides*), paper birch (*Betula papyrifera*), and black cottonwood (*Populus balsamifera trichocarpa*). Common understory species were prickly rose (*Rosa acicularis*), falsebox (*Paxistima myrsinites*), thimbleberry (*Rubus parviflorus*), black twinberry (*Lonicera involucrata*), kinnikinnick (*Arctostaphylos uva-ursi*), and saskatoon (*Amelanchier alnifolia*). The SBSdw had a natural disturbance regime of frequent, large-scale fires on an approximate 300-year cycle, with most stands burning every 125 years (British Columbia Ministry of Forests and British Columbia Ministry of Environment, Lands and Parks 1995). Forest harvesting, using a variety of techniques, has occurred over the past 40 years. Land clearing for cultivation and cattle grazing occurred extensively in most valley bottoms.

METHODS

Fishers were live-trapped, radiomarked, and monitored as part of a larger study on the ecology of fishers in British Columbia (Weir 1995). We located fishers using standard aerial and ground telemetry techniques (White and Garrott 1990). We recorded stand types for all aerial locations and for ground telemetry locations of fishers that had 95% error polygons (Nams 1990) ≤1.5 ha. We performed patch-scale habitat assessments at locations of fishers on which we either homed-in (White and Garrott 1990) or had ground telemetry locations with 95% error polygons ≤3,000 m². We also measured elements at sites used by fishers for resting or denning.

We determined habitat at the stand scale using the biophysical classification system presented by Demarchi and Lea (1989), which classifies stand types according to biophysical unit, structural stage, and forest phase. We identified biophysical units using site series as determined by Steen and Coupé (1997). Stands were assigned 1 of 7 structural stages ranging from nonvegetated to old growth, and 1 of 5 forest phases (coniferous, deciduous, mixed coniferous-deciduous, selectively logged mixed coniferous-deciduous, and nonforested). We considered stands as relatively homogeneous assemblages of habitat with respect to coarse woody debris (CWD), closure of vegetation strata, and other structural attributes. We performed biophysical unit mapping for 405-km² of the total study area, covering the areas where most home ranges of fishers occurred.

We determined boundaries of seasonal home ranges using the 90% utilization distribution of the adaptive-kernel home-range approximation

(Worton 1989). We defined 1 April–14 September as summer, 15 September–14 November as autumn, and 15 November–31 March as winter. We estimated seasonal home ranges from radio-locations collected within 1 season (across multiple years) for each fisher. We estimated each fisher’s home range for seasons in which at least 20 locations were obtained (Weir 1995). We estimated the availability of each stand type for each fisher by overlaying seasonal home ranges on bio-physical maps and using a digital planimeter to estimate the percentage of each stand type available within home ranges.

For our assessments of habitat selectivity, we used information from data collected at 2 types of sites: sites used by fishers and sites we randomly sampled. We used the patch-scale habitat data that we collected at these plots for 3 purposes: (1) to provide estimates of normal (i.e., expected) values of structural variables for each stand type, (2) to quantify the same structural variables in patches used by fishers, and (3) to quantify the structural elements used by fishers. This sampling approach allowed us to assess habitat selectivity at the 3 spatial scales. We performed habitat plots that were designed to quantify structural variables in patches of habitat.

We used the same techniques to measure structure at fisher sites and at random sites. At each plot, we visually estimated cover of 5 vegetation strata (herbs 0–15 cm; low shrubs 0.15–2 m; high shrubs 2–10 m; coniferous trees >10 m; deciduous trees >10 m) in a 400-m² plot around a central point. We estimated the volume of CWD >7.5 cm diameter on 90-m triangular transects following the methods of Brown and Roussopoulos (1974) around the central point as well. We also estimated tree-stocking density and basal area at the plots using variable radius prism methods (Bull et al. 1990), selecting prisms with basal area factors so that between 7 and 11 trees were sampled in each plot (constant tally rule; Wensel et al. 1980). Basal area factors ranged from 2 to 10 m²/ha.

We selected the techniques for assessing CWD, vegetation strata, and stocking density of trees because these are standard methods used by the forest industry in British Columbia. We wanted our results to be compatible with existing forest inventory data, and we selected these sampling methods so that our conclusions would integrate directly into forest management plans.

We randomly sampled each stand type twice to estimate normal values for structural components. We grouped stand types by 15 structural attributes based on structural stage, forest phase, mensura-

Table 1. Classes of structural attributes used to group stands for analyses of stand-scale selectivity of radiomarked fishers in south-central British Columbia, Canada, 1990–1993. Each stand type was assigned to 1 stand class for each attribute, based on the mean value of that attribute at random points within that stand type. Mean electivity indices were calculated for each class of each attribute.

Structural attribute	Stand classes
Structural stage	Herb, Shrub, Pole-sapling, Young forest, Mature forest, Old growth
Forest phase	Coniferous, Deciduous, Mixed coniferous–deciduous, Selectively logged mixed coniferous–deciduous, Nonforested
Coarse woody debris (CWD) (m ³ /ha)	
Total volume of CWD	0, 1–100, 101–200, >200
Volume of CWD >20 cm diameter	0, 1–25, 26–50, >50
Volume of CWD not resting on ground	0, 1–20, 21–40
Vegetation strata closure (%)	
Coniferous canopy (>10 m)	0, 1–20, 21–40, 41–60
Deciduous canopy (>10 m)	0, 1–20, 21–40, 41–60
High shrub (2–10 m)	0, 1–20, 21–40, 41–60
Low shrub (0.15–2 m)	0, 1–20, 21–40, 41–60, 61–80, >80
Stocking density (stems/ha)	
Total stocking density	0, 1–1,000, 1,001–2,000, 2,001–3,000, >4,000
Stocking of trees with rust brooms	0, 1–20, 21–40, >40
Stocking of >40 cm dbh trees	0, 1–50, 51–100, >100
Stocking of aspen trees	0, 1–400, 401–800, 801–1,200, >1,200
Stocking of spruce trees	0, 1–400, 401–800
Tree attributes (cm)	
Mean tree diameter	7.5–15, 15.1–22.5, 22.6–30, >30

tion data for live and dead trees >7.5 cm diameter-at-breast-height (dbh), percent closure of each vegetation strata, and CWD volume estimated at each sample location. Stand types were assigned to stand classes (Table 1) based on mean values of structural attributes at the stand description plots.

We calculated Vanderploeg and Scavia’s relativized electivity index (Lechowicz 1982) to compare use to availability of stand classes for the seasonal home range of each fisher. All suitably precise locations that we collected for each fisher were not included in the stand-scale analysis because our analytical approach necessitated collecting enough locations to adequately estimate home ranges. We determined general trends in selectivity among all fishers by comparing the mean electivity index for each stand class to zero (i.e., no selectivity) using *t*-tests, with significance occurring at *P* ≤ 0.05. We limited analyses to those

Table 2. Seasonal selectivity for stands by radiomarked fishers in the dry–warm Sub-Boreal Spruce Biogeoclimatic zone (SBSdw), south-central British Columbia, Canada, 1990–1993.

Structural variable used to classify stands	Summer		Autumn		Winter	
	Stand classes avoided ^a	Stand classes selected ^b	Stand classes avoided ^a	Stand classes selected ^b	Stand classes avoided ^a	Stand classes selected ^b
Structural stage	Herb		Herb		Herb	
Forest phase ^c		MI		MI	MISL, NF	
Total volume of CWD (m ³ /ha)	0	>200			0	
Volume of hard CWD >20 cm diameter (m ³ /ha)		1–25				>50
Volume of elevated CWD (m ³ /ha)		21–40				
Coniferous canopy closure (%)						21–40, 41–60
Deciduous canopy closure (%)	0	21–40				
High shrub (2–10 m) closure (%)						41–60
Low shrub (0.15–2 m) closure (%)	>80				>80	
Stocking of all trees (stems/ha)	0				0	
Stocking of trees with rust brooms (stems/ha)		1–20		0, 1–20		
Stocking of trees >40 cm dbh (stems/ha)				1–50		51–100
Stocking of trembling aspen trees (stems/ha)		401–800			1–401	
Stocking of hybrid spruce trees (stems/ha)		401–800			401–800	

^a Stands for which mean Vanderploeg and Scavia's relativized electivity index was significantly less than 0 ($P \leq 0.05$).
^b Stands for which mean Vanderploeg and Scavia's relativized electivity index was significantly greater than 0 ($P \leq 0.05$).
^c Forest phases: mixed coniferous/deciduous (MI), mixed coniferous/deciduous selectively logged (MISL), and nonforested (NF).

stand classes that comprised at least 5% of the seasonal home range. By limiting our analysis, we eliminated interpretation problems associated with high use/availability ratios resulting from spurious locations in rare stand types.

For each stand class, we examined patch-scale selection using Mann-Whitney *U*-tests to compare values of the structural attribute at patches used by fishers to values from random plots. We did not compare use to availability for patch-scale analyses.

We collected element data for all resting sites and natal and maternal dens that we located. Tree species, dbh, tree decay class, den height, and number of spruce broom rust (*Chrysomyxa arctostaphylae*) clumps were recorded for trees used for resting or natal and maternal dens. We recorded decay class, diameter, and height above ground for resting sites beneath CWD. We used Mann-Whitney *U*-tests to test for differences in attributes between elements used by fishers and other similar elements within the same patch. Significances of all statistical tests are reported at the $P \leq 0.05$ level.

RESULTS

Stand Spatial Scale

We collected sufficient landscape-scale locations to estimate seasonal home ranges for 9 fishers (8 F, 1 M). For female fishers, summer home ranges averaged 33.0 km² and autumn home ranges averaged 32.3 km². We had insufficient

data to estimate male home ranges during autumn or summer. Winter home ranges averaged 25.0 km² for females and averaged 73.9 km² for the 1 male fisher (Weir 1995). We examined stand-scale selection at 359 locations of these 9 fishers ($\bar{x}_{\text{Summer}} = 27.3$ locations/fisher, SE = 6.2, $n = 7$; $\bar{x}_{\text{Autumn}} = 7.7$ locations/fisher, SE = 0.3, $n = 3$; $\bar{x}_{\text{Winter}} = 28.6$ locations/fisher, SE = 8.6, $n = 6$).

We detected selectivity at the stand scale for all structural attributes that we examined with the exception of mean tree diameter (Table 2). When selection was detected at the stand scale, fishers selected stand classes with moderate values of most structural attributes. Fishers primarily avoided extreme stand classes (i.e., those stands classified as having either extremely high or low values of particular structural attributes). However, we did not detect fishers exhibiting selection for stands with extremely high volumes of CWD during summer or CWD >20 cm diameter during winter. At the stand scale, the structural features for which fishers exhibited selectivity changed among seasons. Although fishers avoided herb structural stages in all seasons, we did not detect fishers showing selectivity for any stand classes across all 3 seasons.

Patch Spatial Scale

We assessed patch-scale selection by fishers from examining 217 locations of 18 radiomarked fishers (15 F, 3 M) because we were always able to

identify the stand in which we located fishers using patches. Fishers exhibited selection at the patch spatial scale for all structural attributes that we examined with the exception of mean tree diameter (Table 3). Fishers exhibited patch-scale selectivity most frequently when using stands with extremes of structural attributes. For example, when fishers used stands with no structure recorded at random points, we often observed fishers selecting patches within these stands that had significantly more structure. Fishers selected patches with significantly less structure in stands that had extremely high values of coniferous canopy, high shrub, and low shrub closures. Fishers also selected patches in stands with high stocking densities of trees >40 cm dbh and trees with rust brooms. In addition, fishers appeared to select patches with a lower stocking density of all trees for stands with 1,000 to 4,000 stems/ha.

Element Spatial Scale

We located 32 resting sites of 9 fishers (7 F, 2 M). Fishers rested in trees (26 of 32, 81%), under single pieces of CWD (4 of 32, 13%), and in piles of logging residue (2 of 32, 6%). We recorded fishers resting in hybrid spruce (17 of 26, 65%), black cottonwood (5 of 26, 19%), Douglas-fir (3 of 26, 12%), and trembling aspen (1 of 26, 4%) trees.

The structures used by fishers for resting were atypical within these patches (Table 4). The dbh of each tree species used for resting were significantly larger than for other stems of that tree species not used by fishers within these patches (hybrid spruce, normal approximation to the Mann-Whitney test, $Z = 2.34$, $P = 0.01$; black cottonwood, Mann-Whitney test, $U = 57$, $P = 0.05$; Douglas-fir, Mann-Whitney test, $U = 78$, $P = 0.025$). Hybrid spruce trees that were used for resting had significantly more rust brooms than spruce trees not used for resting (normal approximation to the Mann-Whitney test, $Z = 6.70$, $P < 0.001$). At CWD resting sites, fishers rested under pieces of CWD that were significantly larger than others that were available within the patch (normal approximation to the Mann-Whitney test, $Z = 3.04$, $P = 0.001$).

We observed 3 female fishers using 5 natal or maternal dens during 2 whelping seasons. Females established natal and maternal dens exclusively in branch-hole cavities in large-diameter, declining (i.e., alive, but showing signs of decay) black cottonwood trees. The black cottonwood trees used for natal and maternal dens were significantly larger than other black cottonwood

Table 3. Selectivity by fishers for patches that were structurally different from the random plots within stands in the dry-warm Sub-Boreal Spruce Biogeoclimatic zone (SBSdw), south-central British Columbia, Canada, 1990–1993. Differences were based on comparisons between patches used by fishers and random patches within the same stand class, with stands classified by each variable. Statistical significance is defined by Mann-Whitney U -tests where $P \leq 0.05$.

Structural variable	Patches selected with less structure ^a	Patches selected with more structure ^b
Total CWD (m³/ha)		0, 1–100, 100–200
Hard CWD >20 cm diameter (m³/ha)		0, 1–25, 26–50
Elevated CWD (m³/ha)		0
Coniferous canopy closure (%)	41–60	0
Deciduous canopy closure (%)	21–40	0
High shrub (2–10 m) closure (%)	41–60	1–20
Low shrub (0.15–2 m) closure (%)	61–80	
Stocking of all trees (stems/ha)	1,001–2,000, 2,001–3,000, 3,001–4,000	0
Stocking of trees with rust brooms (stems/ha)	>40	0
Stocking of trees >40 cm dbh (stems/ha)	>100	0
Stocking of trembling aspen trees (stems/ha)	1–400, 401–800	0
Stocking of hybrid spruce trees (stems/ha)		0

^a Stands in which the patches used by fishers had significantly less structure than measured at random patches within that stand class.

^b Stands in which the patches used by fishers had significantly more structure than measured at random patches within that stand class.

trees within natal and maternal den patches (Mann-Whitney test, $U = 69$, $P = 0.025$; Table 4). The mean height of natal and maternal den cavities was 25.9 m (range = 17.7–30.0 m, $n = 5$) above ground. One female used the same black cottonwood tree for a natal den during 2 successive years.

DISCUSSION

Many of the resource requirements of fishers in the SBSdw appeared to be met across several spatial scales, although fishers exhibited selectivity for different structural attributes at the stand, patch, and element scales. Fishers appeared to use habitats for foraging and snow interception at the stand and patch spatial scales, and they sought resting and natal and maternal denning

Table 4. Differences between elements used by fishers for resting and denning sites and those available within patches in the dry-warm Sub-Boreal Spruce Biogeoclimatic zone (SBSdw), south-central British Columbia, Canada, 1990–1993.

Element	Structures used by fishers			Other structures available within patch			P
	Mean	SE	n	Mean	SE	n	
Resting sites							
Hybrid spruce ^a	46.3	3.9	17	32.1	2.0	66	0.01
Black cottonwood ^a	103.2	16.9	5	62.1	7.9	15	0.05
Douglas-fir ^a	111.0	21.4	3	44.8	4.7	29	0.025
Rust brooms ^b	3.2	0.7	17	0.2	0.1	66	<0.001
CWD ^c	80.3	11.8	4	23.4	2.9	48	0.001
Natal and maternal dens							
Black cottonwood ^a	103.1	12.9	5	52.5	9.4	22	0.025

^a Diameter at breast height (cm).
^b Number of brooms/hybrid spruce tree.
^c Diameter (cm).

habitat at the stand, patch, and element spatial scales. When using stands in which the density of structural attributes may have been low, fishers appeared to compensate for the decreased quality of the stand by selecting atypical patches. Fishers also appeared to select atypical elements within patches to fulfil their most specific resource requirements. Hence, fishers likely have stringent requirements for structural attributes for activities such as resting or rearing kits.

Values of structural attributes within each stand class varied. We occasionally documented fishers using patches with structural attributes in stand classes for which the mean value of the attribute was zero. This was because, although patches of this structural attribute may have existed within this stand class, we did not detect them in our random samples. For example, no CWD was recorded in any of the stand description plots for cultivated fields. These patches were rare enough (e.g., windrows) that they were not sampled, but because they existed within the stand, fishers were able to use them.

Overhead Cover

Our study results support the hypothesis that fishers avoid habitats without overstory or shrub cover. Many researchers have reported that fishers generally select older seral stands with continuous canopy cover to provide security (Coulter 1966, Kelly 1977, Powell 1977, Arthur 1987). Fishers rarely used open areas for foraging (Raine 1981), and if crossing open areas, they usually ran (Powell 1981). In our study, fishers also selected for overhead cover, but did so at both the stand and patch spatial scales. Fishers avoided stands that lacked overhead cover (typically early structural stages), but when in stands with low over-

head canopy closure, they used patches of greater cover within these stands.

Foraging Habitat

Volume of CWD, vegetation layer diversity, and closure of the shrub layers provide a measure of the structural complexity of the forest floor, which is the primary foraging area for fishers (Buskirk and Powell 1994). Fishers exhibited selectivity for stands and patches with high volumes of CWD (total volume and volume elevated above the ground), and specific closures of the high (2–10 m) and low (0.15–2 m) shrub layers. In British Columbia, small mammals and snowshoe hares form a large percentage of the diets of fishers (Weir 1995). Structural complexity of the forest floor likely provides cover for the prey of fishers (Leonard 1980), especially snowshoe hares (Litvaitis et al. 1985). However, an overly complex forest floor may affect the hunting success of fishers by reducing the likelihood of capturing prey. Hunting success may explain why fishers avoided stands with >80% closure of the low shrub layer. Fishers also exhibited selectivity for habitats with some deciduous component at the stand and patch spatial scales. In the coniferous-dominated forests of south-central British Columbia, the structural diversity of stands and patches with a deciduous component likely is higher than other stands, and this may enhance prey diversity for fishers.

Foraging is an important activity that may influence the use of habitats by fishers. Selection of structurally complex habitats that are characteristic of foraging areas appeared to be made by fishers at the stand and patch spatial scales. Fishers tended to select habitats with high structural diversity at both spatial scales, which was reflected by the selectivity for several structural attributes.

Snow Interception

During winter, fishers showed consistent selectivity for stands with extensive closure of the coniferous canopy. Fishers also exhibited an affinity for conifer patches in stands where coniferous trees were not recorded at random sampling points. Fishers have been reported to avoid areas with soft snow that inhibits their movements (Leonard 1980, Raine 1981). Coniferous trees intercept snow (Harestad and Bunnell 1981) and, in our study area, snow packs in coniferous habitats were denser and provided greater support than in other habitat types (R. D. Weir, Simon Fraser University, unpublished data). During winter, fishers may have selected stands and patches with moderate closure of the coniferous canopy because these habitats intercept snow better, have denser snow packs, and thus permit more efficient locomotion than in stands with less coniferous canopy closure.

Resting Habitat

Availability of resting opportunities may also affect habitat selection by fishers. We observed that fishers selected resting habitat at a variety of spatial scales. Other researchers have documented that the habitats in which fishers rest are less variable than habitats they use for other activities (Arthur 1987, Jones 1991). We observed fishers using many different stands and patches in which to rest, but the elements they used were similar among these various spatial scales. In our study, we observed fishers using several types of resting elements, and selectivity was detected for these structural attributes at all 3 of the spatial scales that we examined.

The large brooms in spruce trees caused by spruce broom rust appear to be an important component of resting habitat for fishers in the SBSdw. Spruce broom rust is the aelial state of *Chrysomyxa arctostaphyli* (Ziller 1974), and the brooms often form flat-topped clumps upon which the fishers rest. Fishers selected stands that had rust brooms during summer and autumn, but the most prominent selectivity for rust brooms occurred at smaller spatial scales. Specifically, fishers selected hybrid spruce trees within patches used for resting that had significantly more rust brooms than other spruce trees within the same patch. The brooms caused by *C. arctostaphyli* can form on spruce at any age but occur predominantly on older, large-diameter trees (R. D. Weir, Simon Fraser University, personal observation). The importance of brooms may be season-

al; we detected fishers using rust brooms predominantly during autumn, which is consistent with the hypotheses of Arthur (1987) and Taylor (1993) that at warmer temperatures, branch nests offer adequate thermal environments.

We also observed fishers using other tree species as resting sites, and the structures that were used were qualitatively different than the rust brooms in spruce trees. When using black cottonwood, Douglas-fir, or trembling aspen trees for resting, fishers used cavities in the main bole. These cavities were caused by heartwood decay through branch-holes (black cottonwoods only), cracks in the main bole (Douglas-firs and black cottonwoods), and primary cavity nesting birds (trembling aspens only). Fishers have been reported to use tree cavities as resting sites (Coulter 1966, Powell 1977, Buck 1982, Jones 1991). Our findings show that most of the use of tree cavities by fishers occurred during spring and fall, supporting Arthur's (1987) hypothesis that fishers select tree cavities for resting most frequently in spring and fall because of favorable microenvironments.

In addition to tree sites, fishers have been reported using large-diameter logs as subnivean resting sites to persevere during periods of thermal stress (Arthur 1987, Jones 1991). For small endotherms, microhabitats such as tree cavities or burrows provide microclimates that are quantitatively and qualitatively different from other sites in their environment and subnivean cavities provide the warmest microenvironment during severe winter weather (Taylor 1993). During winter, selection by fishers for stands and patches with high volumes of large CWD (>20 cm diameter) may indicate use of these subnivean CWD resting sites. The volume of CWD appeared to be a factor in habitat selection and selectivity for CWD at the stand, patch, and element spatial scales. In stands with high volumes of CWD, we did not detect fishers selecting for CWD at the patch-spatial scale. However, in stands with less CWD, fishers appeared to seek out and use patches of debris. Selection for CWD was most biologically relevant during cold weather when fishers appeared to exhibit strong selectivity within patches for the largest pieces of debris under which to rest. We detected fishers using ground-resting sites during winter only, and only then when temperatures dropped below -20°C . Evidence from our study suggests that large pieces of coarse woody debris may be a critical element for fishers that face extended periods of severe thermal stress.

Natal and Maternal Denning Habitat

Fishers that whelped offspring were discriminating in their selection of elements used for natal and maternal dens. They only selected large-diameter black cottonwood trees that had begun to decline in viability and exhibited extensive heart-rot. Our observations are consistent with other studies, which report that fishers whelp primarily in cavities in deciduous trees (Leonard 1980, Paragi 1990). Female fishers in our study whelped in branch-hole cavities in deciduous trees, but the trees they used were much larger than trees reported elsewhere. Paragi (1990) reported that females in Maine established maternal dens in trees with a median dbh of 45 cm, whereas females in our study had natal and maternal dens in black cottonwood trees with a mean of 103 cm dbh. In our study area, these large declining black cottonwood trees generally were the largest-diameter trees available and occurred infrequently across the landscape and within the home range of each female fisher.

Fishers may use large-diameter, declining black cottonwood trees for several reasons. First, the cavities within tree boles may have microenvironments suitable for denning. Second, because cavities form primarily through branch-holes in the upper bole, natal, and maternal dens are located high above the ground. Leonard (1980) hypothesized that female fishers select natal and maternal dens at least 10 m above ground to minimize the chance of kit predation by male fishers. The mean height of natal and maternal dens that we observed was 25.9 m above ground. Black cottonwoods may form suitable den trees because the long, straight bole, free of branches, makes climbing to the dens more difficult for large males.

The availability of large-diameter, declining black cottonwoods may be a factor that affects the reproductive capacity of fisher populations in central British Columbia. Black cottonwoods begin to exhibit heartwood decay by maturity, which begins at about 70 years of age (Maini 1968). Extensive heartwood decay appears to occur when the tree has reached 90 cm dbh (R. D. Weir, Simon Fraser University, personal observation), after which black cottonwoods appear to provide suitable dens. Black cottonwoods of this size are rare across the landscape and therefore may be a critical component of fisher habitats. However, whether female fishers could use alternative structures successfully as natal or maternal dens is unclear.

Many forested stands do not reach mature or old-growth structural stages in central British

Columbia because of frequent fires. Stands or patches with sub-hygic and wetter moisture regimes generally are more productive and may burn less frequently than drier stands. Consequently, elements that are associated with older-age stands, such as large-diameter spruce and black cottonwood trees, occur primarily in these riparian and riparian-associated habitats and fishers use these trees in which to rest and whelp. The selectivity by fishers for riparian habitats likely is the result of selectivity for elements that are relatively concentrated in the moist areas at the toes of slopes and around depressions, streams, and lakes.

MANAGEMENT IMPLICATIONS

Our scale-based assessment of habitat selection provides opportunities for different and more effective management prescriptions and broadens the applicability of our results. Recognizing that selectivity for resources by fishers may be compensatory across spatial scales, managers may be able to lessen the negative effects of habitat alterations at large spatial scales by maintaining structural attributes at smaller scales. Future research should be directed toward determining, at each spatial scale, the density of structural attributes required by fishers.

In addition to the introduction of multiscaled management, our results provide a stronger ecological basis for the management of fisher habitat in British Columbia than currently exists. Fishers rely on stand, patch, and element features provided by all stages of forest development. To fulfill their needs, fishers require forests that provide structural complexity and diversity through the natural processes of growth, disease, death, and decay. Forest management that emphasizes tree growth and suppresses other natural forest dynamics, such as that found in a monotypic forest plantation, will diminish the quality of fisher habitat. To ensure the maintenance of habitat for fishers, forest harvesting prescriptions must be developed that provide for retention of appropriate structural attributes from all stages of forest development. Because fishers select resources at several spatial scales, knowledge of which habitat requirements can be fulfilled at each scale allows for more effective and flexible management of fisher habitat.

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